Art. VIII.—*Six Months' Daily Examination of Melbourne Tap Water.*

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Before giving the results of the examinations of the Melbourne Water Supply, a short description of the sources of the water and of the reticulation is necessary in order to explain the results obtained.

Melbourne is probably unique among the large cities of the world in being supplied with water which comes from uninhabited catchment areas. The water supply consists of two systems—the Yan Yean and the Maroondah. The Yan Yean system collects the water from the northern slopes of the Dividing Range in the neighbourhood of Mount Disappointment, about 30 miles north of the city. This catchment comprises 26,500 acres. The most distant source is the Silver Creek, the water of which is conveyed in an open aqueduct, 8 miles long, to the Wallaby Creek Weir. From this point the combined waters of the Wallaby and Silver Creeks are conveyed by a similar aqueduct for 5 miles to the southern crest of the Dividing Range, at a height of 1700 feet above sea level. The water is then dropped by a series of cascades into the bed of Jack's Creek, one of the branches of the Plenty River. Jack's Creek leads to Toorourong Reservoir, with a storage capacity of 60 million gallons, whence a clear water channel nearly 5 miles long leads to the Yan Yean Reservoir. The average flow from Silver Creek is five, and from Wallaby Creek seven million gallons a day.

The Yan Yean Reservoir is 600 feet above sea level. It covers an area of 1360 acres, with an available depth of 18 feet, and a storage capacity of 6400 million gallons. The face of the embankment and a considerable extent of the shores of the reservoir have been pitched in order to prevent discolouring of

the water with the action of the waves upon the banks. From the Yan Yean Reservoir to the pipe head dam at Morang the water is conveyed in an open aqueduct, 7 miles long, and capable of delivering 33 million gallons a day. From this point the water is conveyed by pipes to the local distributing and storage reservoirs. The chief of these is at Preston, 7 miles from Morang.

The Maroondah system is supplied by the Watts River and its tributaries at a point 45 miles to the N.E. of Melbourne, and 3 miles beyond Healesville Railway Station. An aqueduct, 41 miles long, capable (as at present completed) of delivering 25 million gallons a day, conveys the water to Preston Reservoir. As will be seen from the results of our examinations, the bacterial content of this water is practically identical with that from the Yan Yean catchment, but it reaches the consumer direct, while that from the Yan Yean system has the advantage of sedimentation during its storage in the large reservoir.

All the aqueducts are built of stone set in cement, or of concrete, and elaborate precautions are taken to prevent the washing away of the banks or the entry of storm water into the channels. The catchment areas are uninhabited except by the caretakers, all the settlers having been bought out prior to 1887. There is very little animal life of any kind in the forests, and steps are taken to restrict the ingress of tourists. No public road enters the Yan Yean catchment, but the Maroondah catchment is traversed for 6 miles by the road from Healesville to Marysville. At the point where this road crosses the Watts River the village of Fernshaw formerly stood, but all the houses have been removed, and the gardens and orchards allowed to return to a state of nature. The neighbourhood of this bridge is the only place where contamination of the water is likely to occur, and, as a matter of fact, the water below the bridge nearly always shows a few more organisms per cubic centimetre than that taken from the river above the former site of the houses. Whether this is to be accounted for by the drainage from the road or from the old cultivated grounds is a point on which I am not at present prepared to express an opinion. The whole of both catchments is covered with dense forest and undergrowth, and the annual rainfall varies at different points from 40 to 60 inches.

METHODS.

All the samples of water were taken from one of the laboratory taps which is in constant use. The nearest large pipe is a 30 inch main which runs from the Preston Reservoir along the Sydney Road. From this about half-a-mile of 6 inch and 4 inch pipes along Grattan and Madeline Streets lead to the branch which supplies the laboratory.

The water was obtained as nearly as possible at 4 p.m., except on Saturdays and Sundays, when it was taken at noon. 5 c.c. were mixed in a flat glass dish, 7 inches in diameter, with 50 c.c. of nutrient gelatine. The plates were kept at 18°-20° C., and examined after 48 and 72 hours. As far as possible the results of the last count of the colonies were taken, but in some cases the plates became liquefied in less than 48 hours. The average number of bacteria per c.c. was found by dividing the total number of colonies on the plate by 5. The observations extended from 4th July, 1901, to 29th January, 1902.

RESULTS.

Table I.

Average of Each Month.

	No. of Examinations.	Total Number of Colonies.	Average per c.c.
July - - - -	25	7975	319
August - - -	30	8887	296
September - - -	30	2294	76
October - - -	31	2586	83
November - - -	29	1757	60
December - - -	31	2219	71
January - - -	23	4841	210

Total number of observations - - 199

Average of organisms per c.c. - - 154

TABLE II.

NUMBER OF BACTERIA PER CUBIC CENTIMETRE OF TAP WATER.

Day.	July.	August.	September.	October.	November.	December.	January.
1	—	316	53	35	24	56	60
2	—	200	24	12	40	82	86
3	—	6000	87	8	24	94	44
4	90	21	80	120	3	77	40
5	138	480	96	131	6	88	24
6	40	64	7	20	20	168	—
7	93	190	37	90	32	116	10
8	72	117	30	82	40	39	48
9	144	140	106	94	31	72	41
10	190	50	87	95	10	72	55
11	160	12	57	98	56	124	6
12	190	144	186	82	96	94	54
13	128	112	193	128	25	75	50
14	31	78	78	150	95	160	60
15	4800	88	16	101	48	3	141
16	76	55	99	156	78	3	124
17	147	44	48	128	57	64	11
18	90	43	150	121	73	86	—
19	—	72	76	57	41	72	21
20	84	89	67	150	80	60	116
21	30	94	38	73	76	40	112
22	108	44	30	52	80	51	—
23	600	86	100	100	74	80	—
24	124	101	288	112	—	62	23
25	124	28	46	68	179	41	3600
26	—	33	69	52	96	32	—
27	—	36	54	43	80	84	43
28	6	—	31	56	61	50	72
29	200	125	22	52	50	62	—
30	120	56	39	50	152	49	—
31	200	80	—	70	—	43	—

REMARKS.

It will be observed that on three occasions the average number of organisms rose to 4800, 6000 and 3600 per c.c. respectively. If these three are omitted the average for the 196 observations falls to 83 per c.c. Taking its average at 154 per c.c. the results

are undoubtedly good for an unfiltered water supply; at 83 per c.c. they approach the best average results obtained by sand filtration. It will be seen that two of the three abnormal results occurred in the winter months, and the rainfall in the last half of July was unusually heavy. The consequence is that more sediment is washed down the creeks, and the average number of organisms is raised. I am inclined to attribute the three large numbers to a little particle of mud being taken up with the sample, but on the other hand the third case happened in January, when the rainfall and amount of sediment are both at the minimum. So far as we could ascertain there was no interference with the mains or reticulation pipes on these occasions. Leaving out of account the three anomalous results it will be seen that the number of organisms steadily fell from July to January thus:—

July - - -	132
August - - -	99
September - -	76
October - - -	83
November - -	60
December - -	71
January - -	54

As will be seen from the following tables the tap water contains a smaller number of organisms than the mountain creeks. It is considerably higher than the average of the outlet of the Yan Yean Reservoir, or of the Surrey Hills and Caulfield local reservoirs, which are supplied direct from the Yan Yean. As previously explained nearly half the water supplied to Melbourne does not pass through the Yan Yean Reservoir, and therefore loses the advantage of sedimentation. Moreover, the Maroondah water is supplied chiefly in the winter, so as to allow of the large reservoir to be filled ready for summer consumption. This probably accounts for the average improvement as the summer approaches, the results of the examinations of the creeks showing little variation in summer and winter, unless the water was actually discoloured by recent heavy rain. For the same reason the number of micro-organisms bears no direct relation to the temperature of the water. For purposes of comparison the results of the examination of London water are appended.

TABLE III.

RESULTS OF EXAMINATIONS OF CREEKS IN CATCHMENT AREA DURING 1901.

——	March.	April.	June.	December.
Yan Yean Catchment—				
Silver - - - -	200	112	—	200
Wallaby - - - -	40	196	—	256
Jack's - - - -	160	190	—	205
Maroondah Catchment—				
Watt's, above Fernshaw -	—	—	191	126
Watt's, below Fernshaw -	—	—	187	141
Graceburn - - -	—	—	195	160
Donelly's - - - -	—	—	—	120
Intake at Maroondah Weir	—	—	220	175

TABLE IV.

RESULTS OF EXAMINATIONS OF RESERVOIRS DURING 1901.

——	March.	April.	June.	Oct'ber.	Dec'ber.
Yan Yean outlet - - -	49	28	—	—	14
Surrey Hills Local Reservoir -	80	—	52	90	31
Caulfield ,, ,, -	25	—	75	41	42
Essendon ,, ,, -	54	—	100	20	40

TABLE V.

LONDON WATER.—AVERAGE MONTHLY BACTERIAL CONTENT IN 1901.

From the Official Reports on the Condition of the Metropolitan Water Supply during the month of December, 1901.

Month.	Thames, unfiltered.	Thames derived, Companies' filtered.	New River, unfiltered.	New River, filtered.	River Lee, unfiltered.	River Lee, filtered.
January -	4069	49	671	28	450	16
February -	5310	26	800	5	172	18
March -	2303	27	593	10	315	43
April -	2076	15	176	6	177	15
May -	852	9	106	6	209	13
June -	1371	26	204	8	488	56
July -	5560	35	383	13	837	40
August -	1646	22	284	13	223	16
September -	873	19	215	7	266	17
October -	865	13	173	4	155	12
November -	1909	55	280	10	202	13
December -	4065	31	387	18	446	14
Average -	2575	24	356	10	328	22

[NOTE.—The above are the results of 6893 examinations. The samples of the filtered water were taken from the clear-water wells of the various Companies.—T.C.]